

Title: Apparatus and method for breeding shellfish

The invention relates to an apparatus for breeding shellfish such as mussels, oysters and like shellfish.

Shellfish such as mussels and oysters grow by clinging, in preferably flowing water, to each other and/or to elements present in the water, such
5 as stones, plants, threads and the like. For the purpose of breeding shellfish, this is utilized by providing obstacles near the coast to which the shellfish to be bred can properly cling. Depending on the species, the shellfish will cling better to surfaces or to threads and/or to each other.

It has been found that as a result of shellfish farming near coasts, the
10 need for food increases. As a consequence, the growth of the shellfish may be less than desired, with less quality. Moreover, for the purpose of planting, maintaining and harvesting, persons with vessels and the like must approach the breeding locations, which puts a further pressure on the respective area. This is disadvantageous specifically for nature reserves and
15 regions with special and/or vulnerable biodiversities.

One object of the invention is to provide an apparatus with which shellfish can be bred in an economically and environmentally advantageous manner.

A particular object of the invention is to provide such an apparatus
20 with which the need for food especially in coastal areas and vulnerable nature preserves is reduced.

A further object of the invention is to provide such an apparatus with which qualitatively attractive shellfish can be bred.

A still further object of the invention is to provide such an apparatus
25 which is safe in use and in particular enables maintenance, placing seed and/or shellfish and harvesting, even in relatively heavy weather.

A yet further object of the invention is to provide a method for breeding shellfish which obviates at least a number of the disadvantages of the known methods described in the introduction.

These and comparable objects are at least partly achieved with, respectively, an apparatus and a method according to the invention.

The invention utilizes the insight that it would afford particular advantages to breed shellfish at a relatively great distance from the coast, in open water. In such areas, there is a large supply of space and of food for the shellfish and the presence of the shellfish will have a less great impact on the flora and fauna, in particular also as a result of currents that will occur at such places.

An apparatus according to the invention, by virtue of the breeding surfaces arranged above each other, affords a relatively large surface for shellfish to cling to and/or to rest on and/or to cling to each other, while both shellfish conventionally preferring to cling to threads and/or each other and shellfish conventionally preferring to cling to surfaces and/or each other can be bred thereon. As a result of the virtually completely open structure of the frame, water is given an opportunity, in use, to flow substantially completely freely between and along the breeding surfaces and thereby to reach the shellfish.

By the use of floating bodies and/or ballast means, the apparatus, during use, can be positioned in open water, and in particular be wholly or partly sunk, in particular to a depth chosen such that the apparatus, at least the breeding surfaces, are disposed completely under water, at such a position that they sustain substantially no influence from wave action at the water surface. Through directed control of the buoyancy of the floating bodies, in particular using ballast means such as, for instance, water that can be pumped into and out of the floating bodies, the position of the apparatus during use can be accurately controlled and, for instance, be adjusted to operating conditions.

By the use of a substantially open structure with floating bodies with a ballast capacity, a further advantage is achieved in that the apparatus is suitable for open water and has a self-lifting power. During use, the ballast means can be filled, so that the apparatus is forced under the water surface and held so. Water can flow freely along the breeding surfaces for supply of food and removal of waste material. In the case of contaminations, inspection, maintenance, harvesting, and the like, the apparatus can be brought at least in part, and preferably for the most part, above water, thereby allowing ready and fast access in a safe manner.

Owing to the floating bodies being spaced apart a relatively large distance, the advantage is achieved that a great stability is obtained, in particular when the height of the apparatus is considerably smaller than the distance referred to, in particular the smallest distance between the floating bodies. The ratio between the height and the above-mentioned distance is for instance preferably less than $1/5$, more in particular less than $1/7$. Naturally, dimensions and ratios can be optimally chosen in each case, depending on the desired application, location, structure and the like. Of relevance in this connection are, for instance, the number, buoyancy, attitude and structure of the floating bodies.

The breeding surfaces of an apparatus according to the invention are preferably manufactured from plastic, in particular plastic mats, plaiting, plates or the like, having holes therein through which water, but no shellfish, can pass and on which the shellfish can adhere. The breeding surfaces are preferably built up from rows and/or columns of growing elements such as plates, troughs or the like, whose joint base surfaces substantially form the breeding surfaces. Optionally, upstanding edges may be provided, thereby preventing seed and/or shellfish floating or washing away. Paths can be provided between rows and/or columns of growing elements, allowing for instance persons or apparatuses for the purpose of maintaining and planting seed or shellfish and/or harvesting same to move

between the growing elements. Additionally, or instead, the growing elements can be arranged so as to be movable individually or in groups.

Preferably, at least four floating bodies are provided, for obtaining a substantially rectangular frame, with floating bodies at the corners. The floating bodies are preferably substantially cylinder-shaped, at least elongated with a longitudinal axis extending at an angle relative to the breeding surfaces, in particular at an angle of more than 45° and preferably approximately 90°. Thus, a high stability is obtained and the sides of the apparatus can remain open maximally. The breeding surfaces are preferably included within the frame, for additional protection. Floating bodies having a relatively great length and small cross section, such as a cylinder, and whose longitudinal axes extend substantially vertically, moreover provide the advantage that they yield a great stability while involving a relatively small waterline surface, which improves swell. Floating bodies can for instance be manufactured from thin-walled tubes.

The breeding surfaces are preferably arranged relatively closely above each other, without this adversely affecting water flowing between them. For instance, the mutual distance is between 10 cm and 100 cm, more particularly between 10 cm and 50 cm. A distance between 25 and 50 cm gives a high density per volume and hence a relatively large available breeding surface, while the surfaces are sufficiently far apart for, for instance, throughflow, maintenance, placement, support and harvesting.

In an alternative embodiment, within the frame, a number of subframes are provided, each carrying a part of the growing elements. The subframes are individually movable relative to the frame, so that only a portion of the shellfish needs to be brought above a water surface for, for instance, maintenance, inspection or harvesting.

The invention further relates to a method for breeding shellfish such as mussels, oysters and the like, characterized by the features according to claim 15.

With such a method, surprisingly, in a simple, safe and economic manner, shellfish can be bred offshore, in open water. In the method, breeding surfaces are arranged in open water in layers above each other, such that shellfish can attach to them and/or can rest on them, while water
5 can flow along them for nutrition and removal of waste material.

For maintenance, harvesting and other jobs, an apparatus according to the invention can be approached in open water with a vessel for transport of persons and for instance for producing pumping power, whereby the apparatus can be brought wholly or partly independently above water with
10 its own floating means and ballast means, by, for instance, pumping ballast means such as water out of the floating means and/or ballast means in a controlled manner. For bringing the apparatus in a suspended position under water, in turn ballast means is then introduced into the floating means and/or ballast means.

15 Further advantageous embodiments of apparatuses and methods according to the invention are set forth in the subclaims. For clarification, embodiments of an apparatus and method according to the invention will be elucidated in more detail with reference to the drawing, in which:

Fig. 1 shows in perspective view an apparatus according to the
20 invention, with, for simplicity, just one breeding surface schematically drawn in;

Fig. 2 shows in side elevation an apparatus according to the invention, with breeding surfaces next to and above each other, in a suspended position under water;

25 Fig. 3 shows in side view an apparatus according to the invention, in floating position, with a portion of a breeding surface in top plan view;

Fig. 4 shows in side elevation an apparatus according to the invention, in an alternative embodiment; and

Fig. 5 schematically shows in top plan view an apparatus according to
30 the invention.

The embodiments given in the drawing and description are only exemplary embodiments and are not in any way limitative of the invention. Herein, in the different embodiments, the same or corresponding parts have the same or corresponding reference numerals.

5 Fig. 1 shows in perspective view a linked apparatus 1 for breeding shellfish, comprising four cylinder-shaped floating bodies 2, mutually connected by four frame parts 4 built up from substantially tubes, rods or like constructional elements 3. The frame parts 4, together with the floating bodies 2, constitute a stiff construction and function as frame 5. Within the
10 frame 5, a series of breeding surfaces 6 are arranged above each other, of which only one is shown in Fig. 1, for simplicity. The or each breeding surface is built up from a number of rows of growing elements 7, arranged next to each other, with paths 8 between them, over which, for instance, people can walk or a harvesting and/or maintenance apparatus 9 can move.
15 Such an apparatus has for instance an arm or scraper to bring seed onto the breeding elements 7 and/or to harvest shellfish 10 (represented exaggeratedly large) therefrom.

An apparatus 1 according to the invention can be relatively large, so that a high stability and moreover a large breeding surface are obtained.
20 Length, width and height can naturally be chosen on the basis of for instance desired breeding area, stability, allowable movements in or on the water and the like. The height is preferably relatively small in proportion to the horizontal dimensions. By way of illustration, examples of dimensions are given, which should not be taken to be limitative in any way. Each
25 breeding surface can for instance involve a few hundreds of square meters within the frame 5, a breeding surface being for instance 10 to 100 meters wide and 10 to 100 meters long. The height of the apparatus is then for instance between 5 and 10 meters, with, for instance, 10 to 40 breeding surfaces provided above each other, with an intermediate distance of
30 between 25 and 50 cm. Naturally, these dimensions and numbers are given

only by way of illustration and should not be taken to be limitative in any way.

In Fig. 5, schematically, an apparatus 1 according to the invention is shown, with four floating bodies 2 being represented, at the corners of a rectangle. Shown between these is a breeding surface 6, carried by the frame 5. With the aid of broken lines, four further floating bodies 2A are drawn in, adjacent the corners of the breeding surface 6. Such floating bodies 2A may be advantageous for a higher stability, greater buoyancy and/or smaller floating bodies and a simpler construction, since the loads on the frame 5 will be reduced.

The floating bodies 2 have a longitudinal axis A which extends approximately vertically, so that an advantageous floating position is obtained and moreover a maximally open frame can be obtained. Moreover, in this way, a relatively small waterline surface is obtained. Substantially vertical should herein be understood to mean including an angle with a horizontal line that is greater than 30 degrees, more particularly greater than 45 degrees, and preferably more than 60 degrees. Pumping means 11 are provided for pumping water, in particular seawater, into and out of the floating means 2. In this way, the buoyancy of the apparatus can be set in each case, such that the apparatus obtains a desired position in or under the water, as shown in Figs. 2 and 3. Preferably, stabilization means 20 are provided with which in each case the optimum buoyancy of each individual floating body 2 can be set, for instance in view of swell, different loading of the parts of the breeding surfaces 6 or progressive growth of the shellfish. It is preferred that the setting of the position of the apparatus is controlled automatically and preferably passively, for instance with siphon mechanisms or the like. In this way, the necessary maintenance is reduced and safety enhanced. Moreover, no permanent control is necessary.

In an alternative embodiment, the pumping means 11 are placed on a vessel 20, as shown in Fig. 2. In case of maintenance, harvesting, inspection

or the like, these pumping means can then be connected to the apparatus 1, so that the position thereof can be set. Afterwards, the pumping means 11 can then be uncoupled again. With a single vessel 20, several apparatuses 1 can then be served. Moreover, in this way, for instance maintenance, repair
5 and operation of the apparatus have been simplified.

As shown in Fig. 2, the breeding surfaces 6, at least the individual growing elements 7 or groups of growing elements 7, are disposed on rails 12 connected with the frame 5, for instance by cross beams 13. The growing elements 7 are plates or trough-shaped elements with a bottom 14,
10 preferably manufactured from metal or, in particular, plastic. Particularly suitable, though not exclusively so, are thermoplastic plastics such as PE, preferably combined with metal frame parts. The plates or bottoms 14 are preferably perforated or at least provided with apertures, so that water can flow through them and shellfish 10 can rest on them and/or attach to them.
15 Accordingly, the growing elements 7 are individually placeable and removable or possibly slidable relative to each other and/or the frame 5. Via the paths 8, persons or the apparatus 9 referred to can move along the elements 7. Trough-shaped elements 7 have the advantage that the edge 15 standing up from the bottom 14 prevents shellfish being washed off the
20 bottom 14. The upstanding edge 15 is preferably, like the bottom 14, water transmissive and relatively open.

As shown in Fig. 2, the apparatus can be sunk to a depth under the water surface 16 that is chosen such that little influence is sustained from wave action at the surface 16, while the apparatus does not rest on the
25 bottom 21. Anchoring means 17 are provided for keeping the apparatus 1 in place. Such anchoring means can for instance be known anchoring means, used for instance with storage tankers for oil platforms or for mooring ships and the like in the sea. The apparatus 1 preferably has some freedom of movement, so that undesirably great forces on the frame 5 and the breeding
30 surfaces are prevented. In principle, an apparatus 1 could also rest on the

bottom, but preferably this is prevented in order to prevent damage to the apparatus 1 and to the bottom 21.

For e.g. maintenance, planting shellfish and/or harvesting them, the apparatus 1 is preferably brought to the floating position shown in Fig. 3 by
5 increasing the buoyancy of the floating means 2 by pumping water out of them. As a result of specifically the openness of the structure of the frame 5, this can be done in a particularly safe manner. The breeding surfaces are secured, such that they do not dislodge as the apparatus 1 is raised and lowered.

10 In an alternative embodiment, as shown in Fig. 4, within the frame 5 with the floating means 2, a number of subframes 18 are provided, each comprising a series of breeding surfaces 6, at least growing elements 7, above each other. The subframes 18, including the breeding surfaces 6, at least growing elements 7, can for instance move vertically relative to the
15 frame 5, such that only a portion of the shellfish need to be brought above the water surface. To that end, the subframes 18 may be provided with sub-floating means 19, comparable to the floating means 2, but may also be provided, for instance, with mechanical and/or pneumatic and/or hydraulic lifting means or the like, with which at least one desired vertical movement
20 can be obtained. The subframes 18 are preferably provided such that they cannot, at least not unintentionally so, move out of the frame 5. Optionally, the subframes may be coupled to the floating bodies via cables, such that if the floating bodies and/or ballast means are moved down, the subframes are moved up and vice versa. In this way, a simple operation has been obtained.

25 In the drawing, in each case, four floating bodies are shown at the corner points of a rectangle. It will be immediately clear, however, that also other numbers may be provided and/or in other positions, for instance three at the corner points of a triangular frame, or more than four, while some or all of the floating bodies may be offset relative to the corner points. Also,

different frames 5 and/or subframes 18 may be mutually coupled and, for instance, have shared floating bodies, as shown in Fig. 1.

An apparatus according to the invention is preferably placed at a relatively great distance from a nearby coast, for instance more than one sea
5 mile, so that a good food supply is possible and existing flora and fauna are hardly, if at all, hindered. Thus, an apparatus according to the invention can be installed outside the territorial waters.

The invention is not limited in any way to the exemplary
embodiments shown in the drawing and the description. Many variations
10 thereon are possible within the framework of the invention as outlined by the claims.

For instance, separate floating means and ballast means may be provided, the floating means being formed, for instance, by closed tanks and the ballast means being, for instance, water tanks. Also, instead of or in
15 addition to ballast means, pull means may be provided for pulling the apparatus at least partly under water, or hoisting means, such as a pontoon, for at least supporting the hauling of the apparatus to the surface. Electrical and/or electronic means may be provided for (semi) automatically controlling the position of the apparatus and/or of the growing elements.
20 The floating means can be made of different design, for instance as spherical bodies. If this is advantageous to the growth of the shellfish, the growing elements may also be designed to be tiltable to some extent.